Staff Workshop on the California Energy Commission's Public Interest Energy Research (PIER) Renewables Research Roadmaps

PIER Renewables Program: Roadmap Updates
June 3, 2008





PIER Vision

"The mission of the Public Interest Energy Research Program is to conduct public interest energy research that seeks to improve the quality of life for California citizens by providing environmentally sound, safe, reliable and affordable energy services and products. Public Interest Energy Research includes the full range of research, development, and demonstration activities that will advance science or technology not adequately provided by competitive and regulated markets."

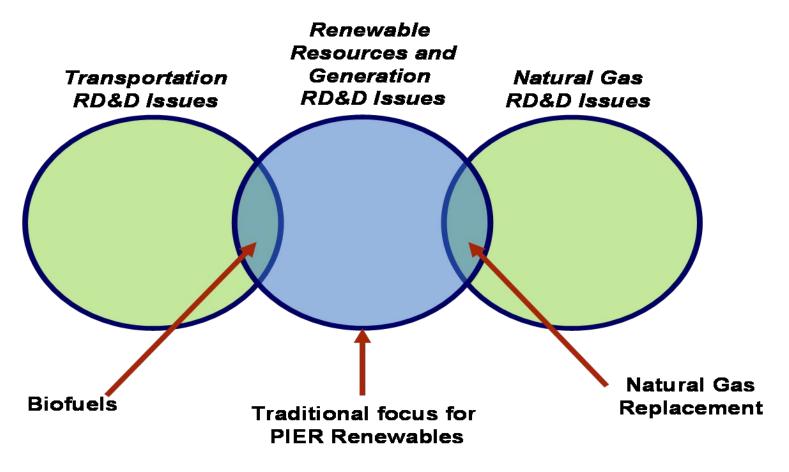
The vision developed by PIER Renewables for the Roadmap is:

"Renewable energy resources will provide at least 33% of the electricity by 2020 for the California energy system, providing consumers and energy providers with affordable, reliable, secure, and diverse clean energy services."





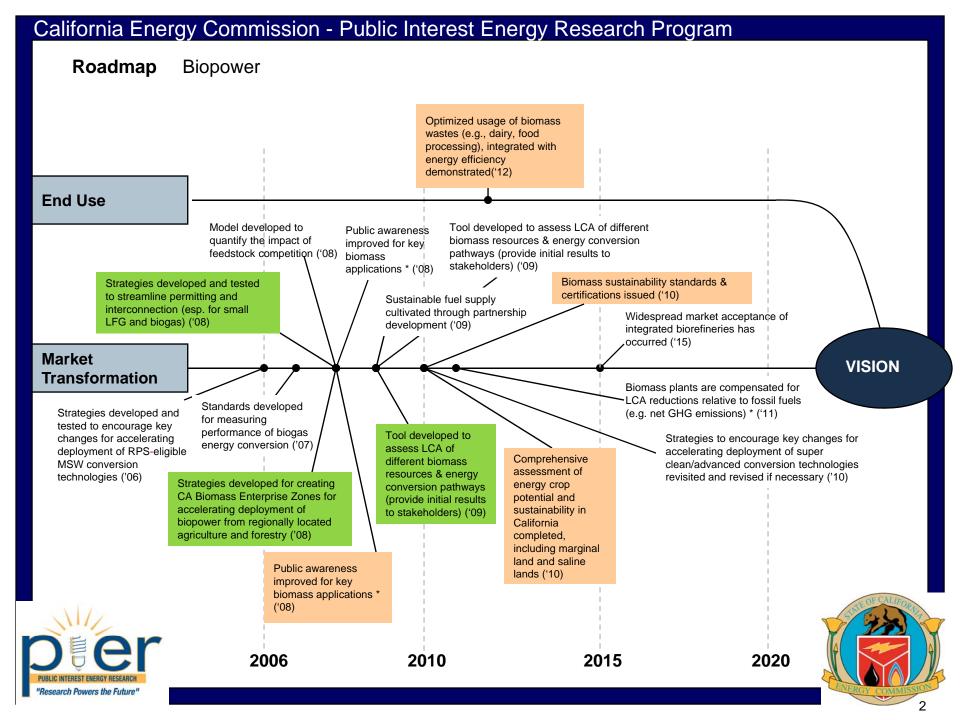
Biomass: Unique RD&D Focus

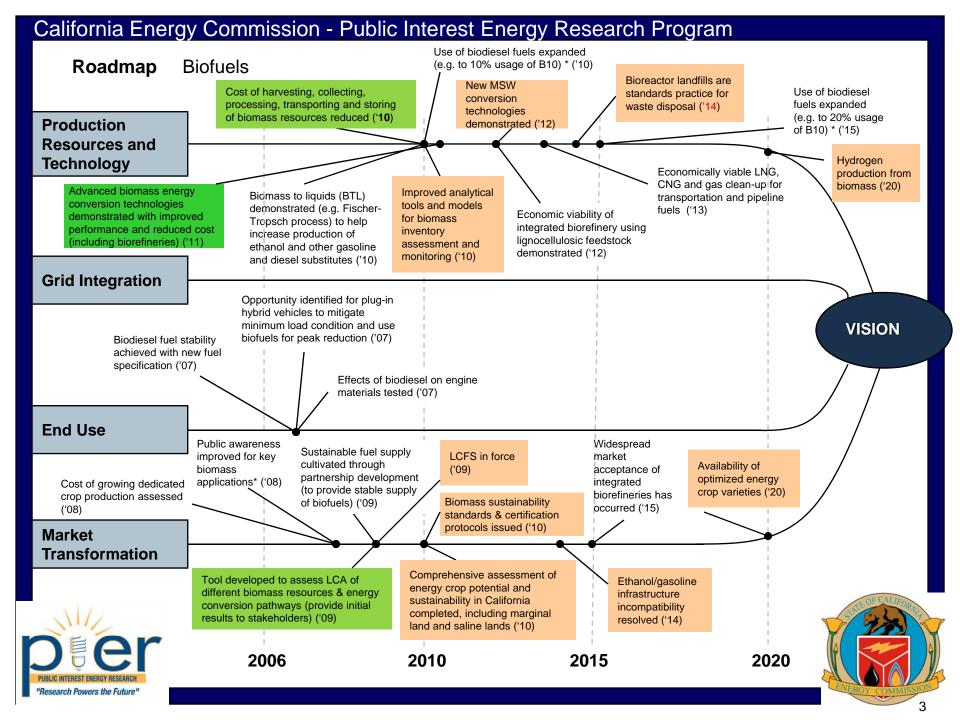






California Energy Commission - Public Interest Energy Research Program Roadmap **Biopower** Assess viability of very large biomass plants Small mobile New MSW conversion Economic viability of (>100 MW or >2,000 tons/day) ('09) biopower (SMB) technologies integrated biorefinery using system for demonstrated ('10) lianocellulosic feedstock dispersed forestry Biomass resource economic potential and access demonstrated ('12) and other assessed (including, forest, MSW, residues, resources energy crops) ('08) Advanced biomass energy conversion demonstrated ('09) technologies with improved performance and Improved processing equipment and reduced cost are standard for new plants ('15) enhanced separation of MSW demonstrated Co-production of value-added and economically viable ('07) products demonstrated in integrated Widespread use of SMB in biorefinery ('09) economically feasible applications ('15) Production Resources and **Technology** CA biomass plants repowered or upgraded Deployment begins of with super clean and/or California-relevant Low emission conversion and gas advanced energy **VISION** biomass-fossil fuel coconversion technologies clean-up of LFG, biogas and firing solutions ('11) (>30% efficiency) ('15) biomethane demonstrated ('08) Major bio-refinery elements Advanced biomass energy demonstrated Bioreactor landfills are Economically viable conversion technologies (09) standards practice for demonstrated with improved LNG, CNG and gas Improved analytical tools and models waste disposal ('15) clean-up for performance and reduced cost for biomass inventory assessment and transportation and (including BIGCC, biorefineries, monitoring ('10) pipeline fuels ('13) CCHP, DG) ('08) Cost of harvesting, collecting, processing, transporting and storing of biomass resources reduced ('10) **Grid Integration** Integration of Smart Grid with biomass and other renewable energy and energy efficiency technologies demonstrated ('12) 2006 2010 2015 2020 "Research Powers the Future





Biomass RD&D Update: Status & Accomplishments

Production Resources and Technology

- Biogas Solicitation: Received 17 proposals (Reviewed & scored 15 and awarded 5). Completed demonstration of 5 low emission conversion technologies (e.g., Makel (HCCI), TIAX (biohalo), SCS (microturbine), Valley Fig (microturbine), FlexEnergy (microturbine)) using landfill gas and food processing wastes.
- Biofuel Solicitation: Received 19 proposals (Reviewed & scored 18 and awarded 3). Bluefire Ethanol declined the award. Executed 2 funding agreements with REII & SFPUC.
- Natural Gas Replacement Solicitation: Received 24 proposal (Reviewed and scored 24 and awarded 4). Prepared
 4 funding agreements for grant awards with GTI, LBNL, Diversified Energy Corp, and SMUD
- Biopower Solicitation: Received 5 proposals (Reviewed & scored 5 and awarded 2). Executed 2 funding agreements with Growpro Inc. & UC San Diego.
- Dairy Power Production Program: Funded 18 systems. To-date 11 systems are now generating 3.3 MW total.
- Programmatic Solicitation: Awarded & completed 3 programmatic projects with Hetch Hetchy/SFPUC,
 Commonwealth Energy & SMUD. Final reports for biomass & other projects are in the publication process.

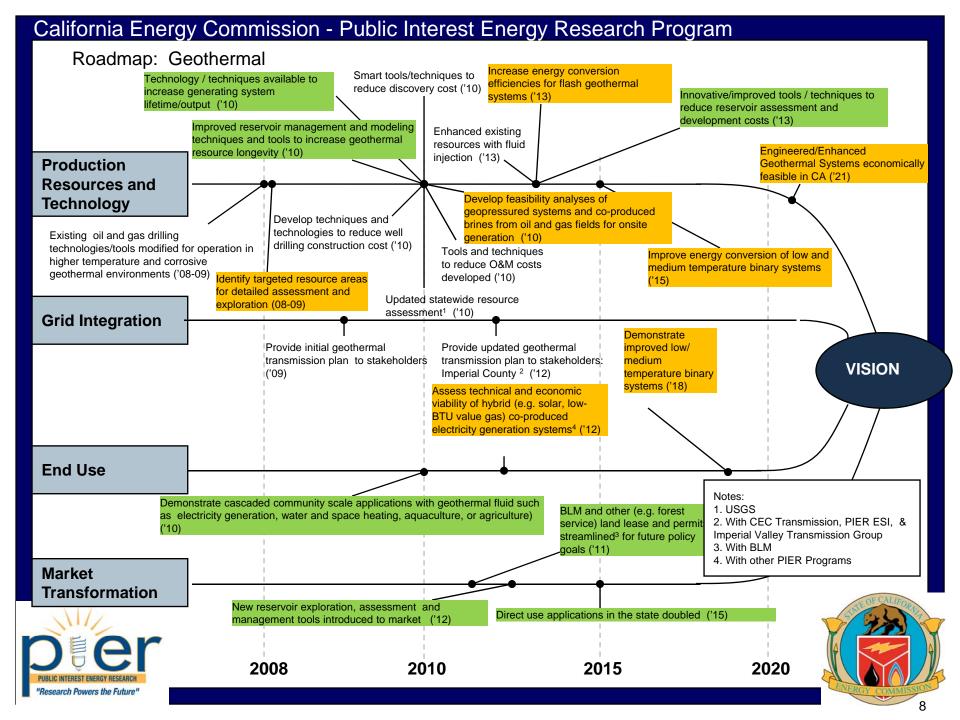
Grid Integration

- Strategic Value Analysis
 - Linking cost competitive biomass resources to electricity system needs while addressing public benefits

Market Transformation

- -California Biomass Collaborative Support
 - Biomass Roadmap for Biomass Development
 - Updated Biomass Resource Assessments
 - Updated Biomass Performance Reporting System
 - Fourth & Fifth Biomass Forum
 - Offered Biomass Short Courses
 - Biomass Information Clearinghouse
 - Technical Support to Bioenergy Interagency Working Group (BIWG)
- Policy Support
 - BIWG Executive Order S-06-06, Bioenergy Action Plan, IEPR, Low Carbon Fuels Standard
 - -Collaborated with other state agencies on their solicitations & AB 32 scoping plan projects (e.g., CARB, CIWMB, CDFFP, CDFA)
 - -Collaborated with USDOE reviewed proposals





Geothermal: Update & Outlook

PRODUCTION RESOURCES AND TECHNOLOGY:

- Exploration: Drilling: Since 2005, drilled new cost-shared wells in four fields.
- Exploration: Geophysics/Remote Sensing: Magnetotelluric surveys; thermal infrared imaging (ASTER TIR)
- Innovative approaches/new applications: First successful, commercial near horizontal geothermal well; Fluid inclusion chemistry: inexpensive, fast technique to identify potential producing geothermal zones.
- Reservoir /Plant Management: Reservoir structure from passive seismic measurements; Field wide fluid injection strategies modeling; Integrated Geothermal System Simulator for coordinating production-injection and power plant operating parameters; silica recovery and evaporative cooling.
- Environmental Mitigation: Microseismicity; remote sensing (InSAR) of surface terrain changes; mercury mitigation

END USE:

 Direct Uses: Canby (Modoc County), district heat system; Weaverville: Ground source heat pump system.

MARKET TRANSFORMATION:

- Stakeholder interaction and research planning efforts (CGEC, GRC; Direct Use Network)
- Statewide resource assessment database (GeothermEx, 2004)





New projects \$5.7 MILLION FUNDED FROM 2007 SOLICITATION GEOTHERMAL PRODUCTION RESOURCES AND TECHNOLOGY

- Development and Demonstration of Improved Steam Scrubbing Technology for Increasing Effective Steam Quality at Wellheads and Power Plants (The Geysers)
- CFEX Self-Expanding Tubulars, (Salton Sea)
- Exploration and Assessment of the San Felipe- Truckhaven Geothermal Area (Imperial Co.)
- Reservoir Confirmation of the Buckeye Power Plant Area, Wildhorse State 36 Confirmation Well Northwest Geysers, Sonoma Co. (The Geysers)

END USE

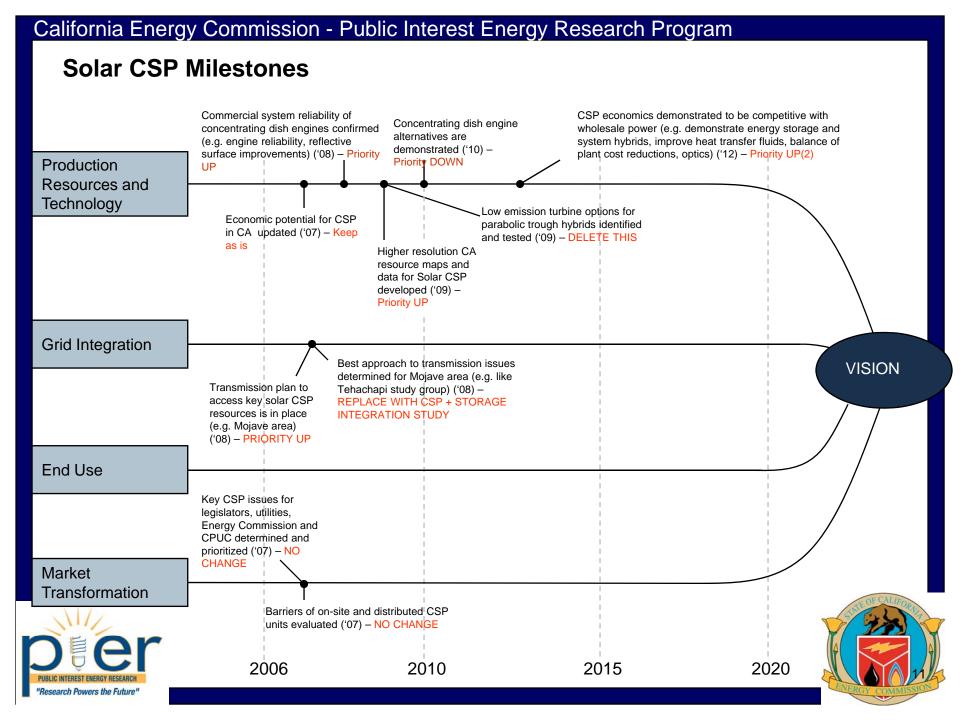
- Canby Geothermal Development (Modoc County)
- Geothermal Well Testing/ Assessment (Fort Bidwell)

MARKET TRANSFORMATION

 Addition by Subtraction: A Roadmap to Improving Adoption of Geothermal Heat Pumps in CA







Additional CSP Milestones

Production Resources and Technology:

Storage, Cooling, Material, and Operational Tool development

- Demonstrate feasibility of thermal storage
- Conduct a study on hybrid (dry/wet) cooling
- Conduct a study on glass coating and IR emissivity
- Conduct a study on heat transfer fluid for high temp. and lower freezing point
- Test a prototype of heat transfer fluid and control system for CSP storage

Grid Integration:

- Conduct CSP/storage/transmission/grid integration feasibility studies leading to demonstrations
- Identify & address technical and business issues of CSP and wind Integration
- Develop tools for CallSO & utilities to operate integrated CSP & wind projects.
- Identify & address operating Issues of CSP: e.g. reliability, dispatchability, etc.



Additional CSP Milestones (Contd.)

End Use:

Develop high resolution solar resource data (1 x 1 mile sq and hourly)

Market Transformation:

- Conduct a study to demonstrate the full value of CSP with storage (from utility perspective)
- Develop a CSP Interagency Action Plan
- Reinvest Natural Gas retirement credits into co-located CSP plants
- Conduct a study on converting Mohave area into CSP projects
- Study the feasibility and benefits of smaller, distributed CSP plants (<50 MW)



RD&D Update: Status & Accomplishments

Funded a major study of Parabolic Trough technology:

Contractor : Solargenix (a subsidiary of Acciona, Spain)

Major Goals:

- Conduct CSP resource assessment
- Develop innovative power purchase agreements for CSP

Accomplishment:

- Developed PPA models and CSP resource assessment for SW states
- PPA helped secure contract with Nevada Power Co. and Sierra Pacific Power that led to the construction of the largest CSP plant in the world (64 MW) in Boulder City, Nevada in 2007. Also built a 1 MW CSP plant (Seguaro Power Plant) for Arizona Power System in Phoenix, AZ.



California Energy Commission - Public Interest Energy Research Program PV RD&D Roadmap Platform 1: Production Technology Highest silicon cell procedures enhanced to more efficiency in market Key barriers to the effectively optimize system 22% (field efficiency) development of PV performance (e.g. moving toward (10) more plug and play or providing mini-grids or options to meet targeted peak loads, central PV are Highest silicon cell efficiency in identified ('07) like summer) ('08) market 25.5% (field efficiency) ('15)**Production Technology** Lifecycle economic and environmental evaluation of Nano and/or organic PV technologies to PV economically Higher capacity factors determine most effective feasible for griddemonstrated (e.g. paths ('08) connected applications **VISION** Potential changes to 20% vs. 18% for ('15)PV system design pitched roof, and and installation similar improvements Building integral PV products for flat roof mount) to requirements caused become cost-competitive by the emergence of meet CPUC PBI targets with rooftop PV and key for CSI ('09) alternatives to technical integration issues silicon-based PV Economic viability of are addressed (e.g. spacing / over the next 10-15 distributed concentrating cooling) ('11) vears understood PV systems (e.g. CIS, CdTe, demonstrated ('09) Spheral Solar, nano, organics, roof-top concentrators) ('07) 2006 2010 2015 2020

California Energy Commission - Public Interest Energy Research Program PV RD&D Roadmap **Platform 2: Grid Integration** Cost / benefits of net _________ Possible net metering arrangements defined to facilitate better cooperation between homes with solar metering (e.g. rate access and neighbors who have shading and / or impacts) understood for SB 1. In addition, impact limited solar access ('08) of raising net metering capacity above SB 1 levels to accommodate Technical and policy analysis complete to CSI goals understood support successful expansion of Rule 21 to (80') cover network interconnection ('09) PV systems with storage or other technologies demonstrate better peak load ('08) **Grid Integration VISION** Economic viability of new PV system storage High value locations for DG PV on T&D are technologies are identified and the impacts / benefits of large demonstrated ('10) concentrations of DG PV in one location on T&D are assessed ('08) Utility acceptance of protocols to allow PV system operation during grid outages ('09) Synergies between PV systems and plug-in hybrids are estimated ('08) 2006 2010 2015 2020

PV RD&D Roadmap

Platform 3: End Use

Potential roles for utilities in solar PV, including attractive business models, are identified and vetted with utility ('08)

New / modified business models create sustained market growth ('08)

Drivers that encourage consumer adoption of PV systems are identified and prioritized ('08)

Operational risks and disputed benefits of PV systems identified (later priority issues to be studied) ('07)

PV system risk to homes and businesses quantified and results made available to financial / insurance industries ('08)

Use of transformerless inverter design widespread ('09)

PV inverter cost reduced 30% (due in part to volume production) and performance improved ('12)

Building integral PV products (e.g. PV replacing roofing material or side / curtain walls) are commonly used in new buildings (residential, commercial, industrial) ('17)

VISION

End-Use

Synergies between building energy efficiency and PV are identified and business models to encourage synergies in retrofits and new construction are identified ('08)

Lower cost, utility grade PV system control, metering, and monitoring capability developed consistent with 1% cost parameter established by CPUC for CSI (e.g. first 5 years of metering, communication and reporting cost do not exceed 1% of installed system cost) ('08)

Field tests done to quantify operational risks and benefits of PB (work heavily with utilities) ('10)

Business models developed to address the fact that homeowners and renters move frequently (e.g. develop modular / portable PV systems or approaches to avoid penalizing new owners with up-front cost of PV system) ('09)

Improved PV economics demonstrated using advanced metering, price responsive tariffs (e.g. TOU, TR, Feed-in Tariff) and

storage ('10)

2006 2010 2015 2020

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17

California Energy Commission - Public Interest Energy Research Program Platform 4: Market Transformation PV RD&D Roadmap Barriers identified to the Key barriers to moving CA to adoption of PV for use on Performance Based Incentives Key relevant RD&D results public sector buildings (e.g. state/local government and strategies from Germany (PBI – kWh) from capital rebates buildings, State water project) and Japan are identified and (kW) are addressed ('09) ('07)recommendations made for application in CA ('08) Solar training and educational materials developed for architects. building land-use planning, and roofing Options for including PV as part of personnel ('07) CA residential building efficiency standards are developed and vetted with industry and policymakers ('10) **VISION Market Support** Updated training for CA installers and building code Differences in policies / Building standards established officials developed and regulations between Western that require sufficient PV-ready vetted with states are identified relative to roof space in new construction industry/policymakers ('07) CA and recommendations (e.g. minimize shading from structural components, offer easy made to address differences Module certification in CA is closely that impede market growth in connection to grid) ('11) aligned with national and international CA ('09) standards, resulting in more robust and accurate ratings ('08) 2006 2010 2015 2020

PV RD&D OPPORTUNITY AREAS:

Area 1. Plug and Play Innovation:

Developing value-added components, sub-systems or packaged systems that reduce installed cost through standardization and/or simplification of design and installation

Area 2. High Value Systems and Energy Storage:

Demonstrating value enhancement and cost competitiveness of PV systems through high value applications, such as: integration of PV with advanced metering and storage to achieve better coincidence with peak load

Area 3. Grid Integration:

Developing alternatives to current grid integration standards, procedures, and policies, and establishing the impacts of higher net-metering cap, alternate rate structures, and high penetration of distributed PV on the grid.

Area 4. Innovative Commercial Offers:

Evaluating and developing innovative business models and financing mechanisms to accelerate market uptake and support sustainable growth of PV.





Applicant	Project Title	PIER Funds Recommended
GreenVolts	Low Cost Installation of Concentrating PV	\$250,000
SolarTech (SV Leadership Group)	Enabling Photovoltaic Markets in California Through Building-Integration, Standardization and Metering in the Carbon Economy	\$747,253
Tilt Solar	Demonstration of a Novel Low-Cost Two-Axis Solar Tracking System	\$246,816
GreenRay	Development of an AC Module System	\$250,000
Gaia Power Technologies	Modular Turnkey Energy Storage Systems for Integration with Photovoltaics	\$247,816
UC Merced	Development and Demonstration of a Concentrating PV System for Commercial Applications	\$258,115





California Energy Commission - Public Interest Energy Research Program Key barriers for Roadmap **Utility Wind** repowering and Impact of Climate developing new Change on wind 60% of CA aging wind fleet is repowered (e.g. generation (2010) wind sites Altamont Pass)* ('10) Wind resource & generation identified and database accessible to PIER & prioritized ('08) industry (ongoing) Low wind speed technologies **Production** mature and deployed ('12) Resources and **Technology** Avian mortality reduced at Viability of off-shore wind Existing wind resource areas key CA sites* ('12) opportunities in CA reassessed ('15) are expanded in land area Tools/techniques for mitigating and optimized for performance Avian assessment tools avian mortality validated and used (e.g. expanding the Tehachapi Shaped or firmed renewable and prescribed guidelines by industry (ongoing) wind resource area) ('08) products available to provide the developed ('07) necessary flexibility for Reliable forecasting tool developed and made renewable generators to available to CAISO and utilities for integration into structure their contracts ('16) resource planning ('09) Wind transmission access Impact of variable plan integrated with other resources Utilities recognize and manage various types of generation renewables ('07) understood ('07) technologies with different capacity values (e.g. evaluate resource adequacy, on and off-peak generation) ('08) **Grid Integration** VISION Intermittency management Utility scale Tools to assess Cost effective storage technologies capabilities demonstrated storage technology impact of next facilitate dispatchability of wind and T&D benefits quantified demonstrated and increment of resource ('15) (80)T&D benefits intermittent quantified* ('10) resources Shaped and firmed products developed ('09) CA wind grid validation data ('10) (e.g. pumped hydro and **End Use** system power) identified and developed to help meet RPS (80)Electricity market structure "accommodates" variability Building integrated urban Assess favorable contract of wind resources at high wind technologies mature Periodic market assessment of mechanisms available to encourage technology and grid integration needs penetration ('12) and deployed ('20) repowering and development of wind for meeting future policy goals (e.g., projects ('10) 33% by 2020) ('10) Market **Transformation** Periodic market assessment of Study transition from utility technology and grid integration needs Public education / benefits of wind Significant progress on land-use scale to community scale for meeting new policy goals (e.g., communicated (e.g., stakeholder and avian issues, among others, integration needs ('12) 33% by 2020) ('15) workshops, open-house tours. addressed to reduce public training sessions) ('07) opposition to siting new technology wind facilities (e.g., low wind speed) ('14)2006 2010 2015 2020 "Research Powers the Future

Update: Wind

- Production Resources and Technology
 - Improvements to modeled wind maps at 4 areas (Mojave, San Gorgonio, Antelope Valley, Mayacamas Mtns)
 - Sodar and tall tower measurements, publicly available data
 - Wind demo portal
 - Wind resource profiles for new sites
 - Boundary layer research to improve modeling efforts
- Grid Integration
 - CA specific wind facility and transmission characteristics
 - Wind-Storage-Enhanced Transmission R&D Solicitation, 2 projects
- End-Use
 - CWEC outreach and technical training activities (technician & small wind systems)
 - FAA obstruction lighting research
 - Summary of setback and permitting requirements
- Market Transformation
 - Past, present & future report to give the facts on wind turbine technology trends and grid-friendly improvements
 - Stakeholder interaction (utilities, WGA, AWEA, PowerGen)
 - Wind research planning efforts (CWEC, utilities, industry)



